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ABSTRACT
The objective of this multimedia kit is to provide third and fourth grade children with materials with which they can interact, and which will help them to explore a selected part of their environment. By examining the fruits and seeds in the box, by experimenting with them, and by watching them grow, children will acquire skill in manipulating small objects; devising and designing experiments; predicting, observing and recording results; and explaining and testing their conclusions. The kit contains seeds, fruits, maps, data charts, books, equipment for experiments, and a film loop. Suggestions for using the materials are presented in the form of 11 lesson cards. In addition, there are suggestions for things to do before and after the kit. Background information on the material in the kit is provided for the teacher, as well as a bibliography and film list. A short history of the MATCH Box Project prefaces the guide. (JY)

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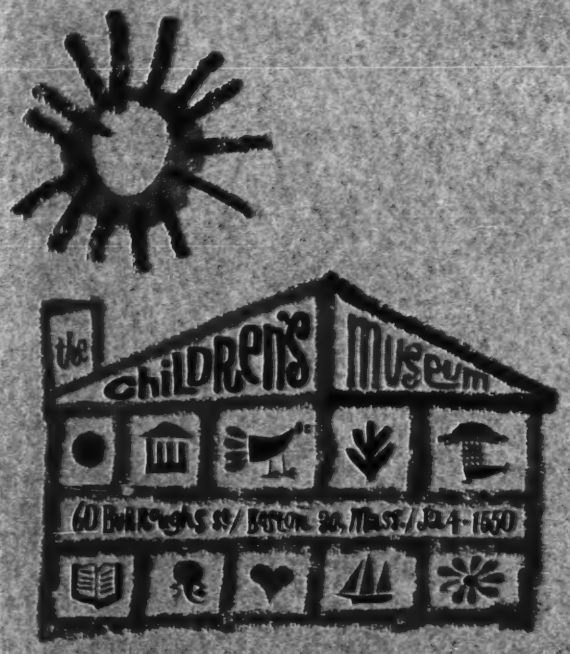

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TEACHER'S GUIDE

SEEDS

THE MATCH BOX PROJECT

Materials and Activities for Teachers and CHildren

The material in this publication was prepared under a contract with the United States Office of Education as authorized under Title VII, Part B, of the National Defense Education Act of 1958.

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Teacher's Guide to

S E E D S

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the CHILDREN'S Museum
60 Burroughs st/ Boston 30, Mass./ J2 4-1550

PREFACE

In 1909, a group of Boston teachers formed the Science Teachers' Bureau. Its purpose: "...the exchange of ideas and materials among teachers of science. Specimens of birds, flowers, minerals, etc., used in science teaching are to be sent...to the different schools of the city."

In 1913, the Bureau established the Children's Museum, which from the outset loaned materials and exhibits to schools and other organizations. Our present loan program was begun in 1937, and today we have Loan Boxes on over 100 topics. More than 5,000 "loans" are made each year to teachers in 400 Boston area schools.

In June 1964, under a contract with the United States Office of Education, we started the MATCH Box Project. The term "MATCH" stands for Materials and Activities for Teachers and CHildren. A MATCH Box contains materials, equipment, supplies and activities designed as a unit to foster the teaching/learning of specific subjects at the elementary school level.

Oddly enough, the underlying purpose of the MATCH Box Project is not to make MATCH Boxes. Instead, we are trying to find out more about the role that real objects play in the learning process, and to discover principles for combining materials and activities into effective teaching/learning instruments.

These are the first five MATCH Boxes that have been developed: GROUPING BIRDS (grades K-2); THE CITY (grades 1-3); THE ALGONQUINS (grades 3,4); SEEDS (grades 3,4); and A HOUSE OF ANCIENT GREECE (grades 5,6).

In terms of the materials that the Museum has previously made available to schools, the MATCH Boxes are quite new:

> Each one is developed by a team made up of Museum staff members, subject matter specialists and experienced teachers.
>
> Each contains a variety of both materials and activities designed to do individual jobs, but also to "work" together as a unit.
>
> In every box there is a Teacher's Guide, with lesson ideas, background information, ways of preparing for the Box, etc. The Guide serves to organize and activate the three-way encounter between the materials, the teacher and the children.

As part of the development process, both materials and activities are tried out in the schools, modified, tried out again, etc. Prototype boxes are then evaluated more formally in typical classroom situations, and revised prior to regular distribution to the schools.

But if one considers the MATCH Boxes from the point of view of Museum traditions, they aren't new at all. Like the Science Teachers' Bureau that got us started, the MATCH Boxes continue to keep us involved in "...the exchange of ideas and materials among teachers...."

Please let us know at any time what you think about this MATCH Box or any other materials that you receive from the Museum.

Frederick H. Kresse
Project Director
MATCH Box Project

September 1965

ACKNOWLEDGMENTS

The following people are members of the Development Team for the Seed Box.

Gillian Standring, Museum Assistant, The Children's Museum.
Sharon Williamson, Museum Assistant, The Children's Museum.
Ellen Kaplan, formerly Museum Assistant, The Children's Museum.
Elizabeth Dudley, botanist.
William Read, Elementary Science Supervisor, Lexington Public Schools.
John E. Jacobus, Elementary Science Supervisor, Lexington Public Schools.
Katherine Mitchell, Fourth Grade Teacher, Smith School, Lincoln.

We appreciate the helpful suggestions and patient effort of the teachers who have tried out the Box in their classrooms:

Mrs. Goldberg and Miss O'Hare, David Ellis School, Boston.
Miss Regele, Agassiz School, Boston.
Mrs. Wilson and Miss Keith, Lesley-Ellis School, Cambridge.
Miss Helen Martin, Davis School, West Newton.
Mr. Gerald McGrath, Ellen Richards School, Boston.
Mrs. McCarthy, Ray School, Franklin, Massachusetts.

We want to thank Theodore Dudley, of the Arnold Arboretum of Harvard University, for the loan of many books and for obtaining fruits and prepared soil for the Box. Sources of some other fruits were: Kilgore Seed Company (peanuts); Seaview Farms, Honolulu, Hawaii (coconuts); Bryce Canyon National Park, Utah (tumbleweed); Arizona-Sonora Desert Museum, Arizona (yucca, grapple plant pods, tumbleweed); Ocean Spray Cranberry Company (cranberries).

The Data Charts were painted by Susan Phelps, and photographed by Michael Sand and Richard Faller; we would like to thank them all for their cooperation and skill.

We are also very grateful to Mrs. Margaret Meyer, Mrs. Ann Paulsen and Miss Betsy Thompson for all their patient and careful editing of this Teacher's Guide.

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Preface

Acknowledgements

SECTION I ABOUT THIS BOX

SECTION II THE BOX CONTAINS...

SECTION III USING THE BOX IN THE CLASSROOM

SECTION IV BACKGROUND INFORMATION

SECTION V FURTHER EXPLORATIONS

I - ABOUT THIS BOX

Children are naturally curious about their surroundings and eager to explore them. Young children, in particular, are much more interested in real, tangible things than in abstract ideas or distant events; and they learn best when all their senses are being stimulated. The objective of this Seed Box, therefore, is to provide the children with materials with which they can interact, and which will help them to explore a selected part of their environment.

Seeds as living organisms are especially suitable for study by elementary school children because they illustrate two basic and fascinating aspects of all living things: their growth from a small, relatively simple organism into a very complex adult plant or animal; and their great variety of size, shape, form, and function. The children will also have the opportunity to discover, through experiments, that when an animal or plant performs some special function, it is adapted in its structure to carry out this function. Fruits and seeds illustrate this fact well: those that travel by air are light and have a " wing " or " parachute "; while those carried by animals have tiny hooks with which they cling to fur or feathers.

The Seed Box is also designed to help children learn the importance of seed dispersal in the reproduction and survival of plant species. Dispersal has an importance for human beings who are concerned with growing particular plants in particular places, such as gardeners and farmers.

Seeds, as objects, have the advantages of being easy to obtain, handle, and examine. Classroom experiences can therefore be extended by the children's contact with seeds and their products at home as well as in gardens, on farms and in stores.

By examining the fruits and seeds in the box, by experimenting with them, and by watching them grow, young children will have opportunities to acquire a number of skills. Chief among these are the skills of manipulating small objects; of devising and designing experiments; of predicting, observing, and recording results; and of explaining and testing their conclusions. The more opportunities that the children have to arrive at their own conclusions, without prompting from the teacher, the more satisfaction they will gain from the whole experience.

Most of the suggested activities are quite short: it is hoped that they will be used to pose real problems so that the children can make their

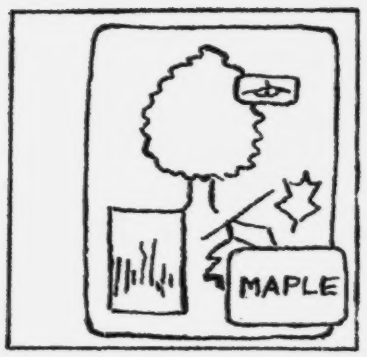
own careful observations and reach their own conclusions without having been told ahead of time what results to expect. In this way, after first using intuition or trial-and-error methods, the children will move to purposeful and deductive ways of solving a problem. Perhaps some children will also glimpse the intellectual adventure involved in making a scientific discovery.

II - THE BOX CONTAINS...

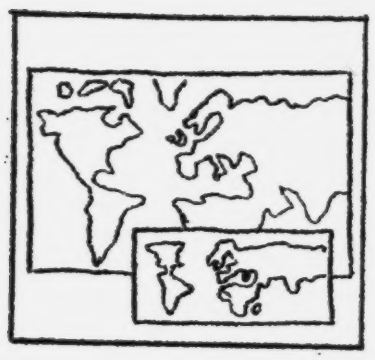
The materials in the box are listed and pictured below. The use of these materials is discussed in Section III: Using the Box in the Classroom.

You will find more detailed information about the fruits and seeds in Section IV: Background Information for the Teacher, and on the Data Charts mentioned below. The pictures of the materials are not life-size. Wherever numbers are not mentioned, you will find sufficient quantities for a class of 40.

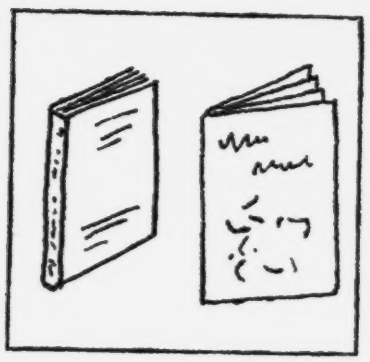
SOURCES OF INFORMATION



Data charts and name cards for each of the eight basic common fruits listed. The data charts are 11" x 14" and each shows the parent plant, habitat, leaves and fruit; there is additional information for the teacher on the back of each chart.

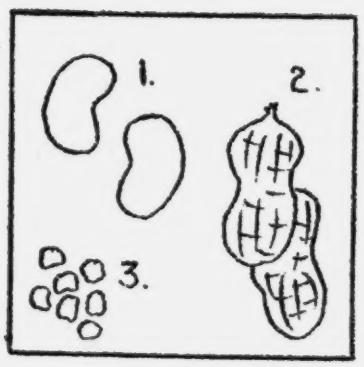


A large world map, showing the dispersal of coconuts and navigator plant pods by ocean currents; and the apple-growing areas of the United States. Small outline maps of the world and the United States, to be used by the class.



Birth of an Island, by Millicent Selsam (20 copies)
The Story of Johnny Appleseed, by Aliki (1 copy)
"Seeds and How They Travel" - Audubon Nature Bulletin (1 copy)
"Seeds" - Cornell Science Leaflet (1 copy)

FRUITS AND SEEDS

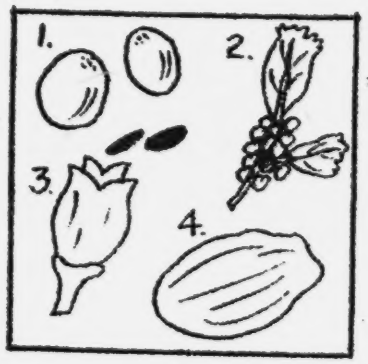


Fruits and seeds for dissection and for planting:

1. Beans
2. Peanuts
3. Radish or grass seeds

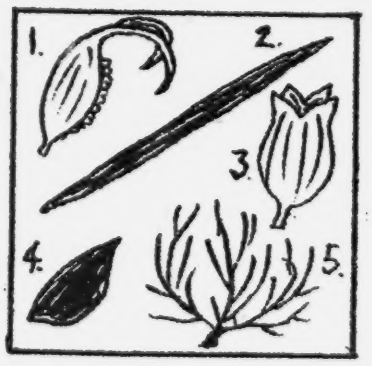
Common fruits to be used in experiments:

1. Maple
2. Milkweed
3. Acorn
4. Burdock



More common fruits to be used in experiments:

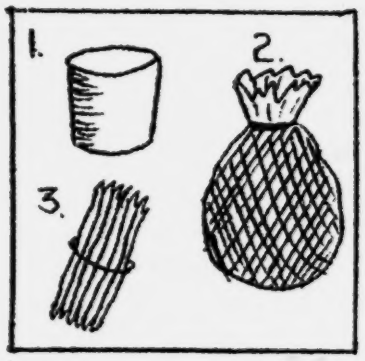
1. Cranberry
2. Bayberry
3. Witch hazel
4. Coconut (1 only)



Some unfamiliar fruits:

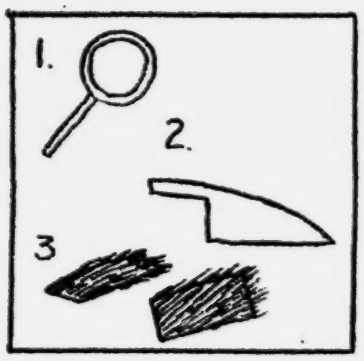
1. Grapple plant (2 or 3)
2. Catalpa (6)
3. Yucca (6)
4. Navigator plant (2 or 3)
5. Tumbleweed (1 whole plant)

EQUIPMENT



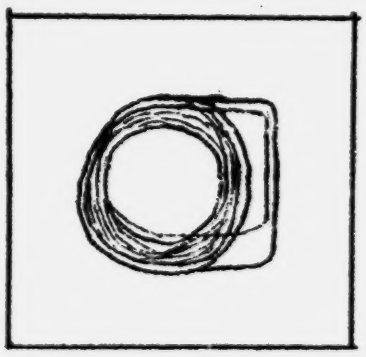
Materials to be used in experiments:

1. Paper cups for floating and growing seeds
2. Prepared soil
3. Toothpicks, to be used as probes



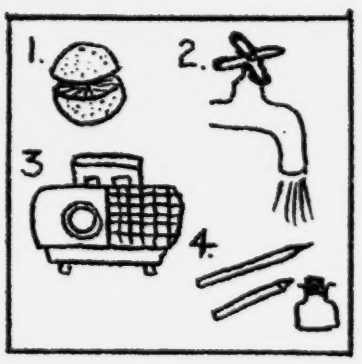
More materials to be used in experiments:

1. Magnifiers
2. Scoop for filling cups with soil
3. Pieces of fur



Film loop:

"Mechanical Dispersal of Seeds"



Other equipment needed but not included in the box:

1. 1/2 an orange for each child (have them bring their own)
2. Water
3. 8mm film loop projector
4. Drawing materials, glue

III - USING THE BOX IN THE CLASSROOM

LESSON CARDS

Our suggestions for activities using the materials in this MATCH Box are presented in the form of lesson cards. These are intended to give enough information so that you need do no additional research or preparation.

It is hoped that the activities will be flexible enough to be of help both to the teacher who uses the box as a self-contained unit and the teacher who has selected a lesson for a specific purpose without intending to teach the entire box. The lesson plans therefore are planned to lend themselves to easy rearrangement and do not necessarily have to be taught in the indicated order.

The lesson plans are based on the recommendations of experienced teachers who have used this box in classroom tryouts. The plans are offered as a guide and you should feel free to adapt them to your particular needs and class situation.

CODE BLOCK

Each lesson plan contains a <u>card code block</u> in the upper right-hand corner. This shows an identification letter and the approximate lesson time. It also indicates whether the activity is intended for the class as a whole, for smaller groups, or for individual children.

30 - 40 minutes
---
groups

A

BACKGROUND INFORMATION

Additional information about the fruits and seeds, as well as a glossary of botanical terms used in the lesson plans, is included in Section IV of this guide, "Background Information."

SUPPLEMENTARY ACTIVITIES

BEFORE THE BOX ARRIVES

1. Have the class collect plants or parts of plants (leaves, twigs, fruits, seeds, bulbs) at home, on the way to school, and on field trips. These can be used in a preliminary discussion of what the various parts of a plant do, and how to tell one part from another. It is not necessary to identify all the plants.

2. Grow beans, peas, corn, sunflowers or other seeds on blotting paper to watch the growth of a seed. Make a cylinder of blotting paper to line a glass jar; slip the seeds between the glass and the paper; keep about 1/2 an inch of water in the bottom of the jar by refilling when necessary.

3. Have the class collect soil and containers (glass, foil, plastic, etc.) for later planting experiments.

4. Obtain books, films, etc., about plants, fruits and seeds. (See lists in Section V, "Further Explorations.")

5. In spring, look for newly sprouting seedlings outdoors in gardens, vacant lots and woods. Discuss how these arrived at the places where they are now growing. This could lead to a discussion of what "weeds" are, and of the reasons why people plant seeds.

AFTER THE BOX HAS BEEN RETURNED

There are many ways you could follow up this unit on seeds. You could study in greater detail: the growth of plants; seed dispersal by man; volcanic islands and their colonization; or the interdependency of plants and animals. Here are some specific suggestions:

1. Collect pictures and objects which look like, move like, or feel like, the fruits and seeds which have been studied: for example, planes, parachutes, boats, windmills, helicopters, Velcro (the hook and loop material used in dress fastenings). Most of these objects can be found in any 5¢ and 10¢ store.

2. Build a model of an island or any other terrain, to show places

where particular plants might grow. Use clay or plaster of Paris.

3. Pull a blanket or cloth through a field to collect seeds and fruits. Look for what makes these stick to the blanket. Try to find out the names of these seeds and fruits.

4. Make a field trip to collect fruits and seeds washed up on the shore line of a lake, river or ocean. Try to identify them and find out where they grow.

5. Build a bird feeder. Watch the birds eat the fruits and seeds you put out for them. What becomes of the seeds? Are they dropped? Wiped off? Passed through the bird?

6. Collect fruits and seeds at home and in stores. For example: herbs, spices, fresh fruits and vegetables. Try to find out their places of origin and methods of travel. Paste them on a large outline map of the world to show their places of origin and their present distribution. Also determine what plants are used for food, for clothes, and for medicine.

7. Take a trip to a greenhouse or nursery to see how seeds are planted by the gardener for specific purposes: food, or decoration. Watch the stages in the growth of seedlings, and find out how to care for them.

8. Let the children collect things they think will float in water, to emphasize the relation between floating and structure. They might bring to the classroom: corks, fishing floats, balls, toy boats, bath toys, steel wool, sponges, wood, etc. Ask each child to explain how an object floats, and to test its buoyancy in a pan of water.

YOU MAY WANT TO USE THE LESSONS IN ONE OF THESE SUGGESTED SEQUENCES

If the season is:	You could do these activities before the box arrives:	Then use the introductory lesson:	Any of these lessons could then follow:	You could finish with any of these lessons:
Fall	Collect leaves, twigs, fruits and seeds Watch seeds and fruit travelling out-of-doors	A. WHAT ARE FRUITS AND SEEDS?	B. HOW DOES YOUR GARDEN GROW? C. GETTING TO KNOW SOME FRUITS D. FRUITS ON THE MOVE E. AIRBORNE: or WINGS AND DISCS F. FLOATING FRUITS G. HITCH-HIKING FRUITS J. WHO PLANTED APPLE TREES?	H. THE STORY OF AN ISLAND I. FRUITS WE HAVE FOUND K. PLANT TRAVELS
Winter	Collect containers and soil for experiments Watch birds and animals collecting food for the winter Study hibernation			
Spring	Grow peas and beans on damp blotting paper Look for newly sprouting seedlings out-of-doors			

30 minutes
---
whole class

A

WHAT ARE FRUITS AND SEEDS?

DESCRIPTION

The children examine and dissect peanuts and beans to find the answers to these questions: "What is a fruit? What is a seed?"

OBJECTIVES

To introduce the parts of a fruit and a seed, their functions, and the relationship between a fruit and a seed.

MATERIALS

From the Box: peanuts; beans (soaked in water for 12 hours before lesson); toothpicks; magnifiers.
From the classroom: 1/2 an orange for each child; paper; pencils; glue or clear tape.

PROCEDURE

Before the lesson, soak the beans in water for 12 hours to soften them.

1. Introduce the subject by giving each child 1/2 an orange and asking the class, "What is this? What is inside?" The children should all see the seeds inside the fruit. Then ask them, "Why are the seeds inside the fruit?"

2. When they have suggested several uses of the fruit, including providing food and protection for the seeds, pass out to each child a peanut and a bean. Tell the class to find out what these are by looking at them with magnifiers and then opening them up using toothpicks. (If necessary, show them how to use the magnifiers and how to split the covers of the peanut and bean with the point of the toothpick.)

3. After about 5 minutes, ask the children to report on what they have discovered. They should have seen the peanut's hard rough shell (fruit wall); two small brown "nuts" (seeds) inside and a thin brown covering (seed coat) which can be peeled off each nut, leaving a tiny baby plant hidden between the two halves (food stores). In the bean, they should be able

to see the scar of attachment of the seed to the fruit and the young root showing through the tough but transparent skin (seed coat). Having peeled off the skin, they will find two halves (food stores) surrounding the tiny baby plant with its root, stem and leaves. Use everyday names for the parts of the peanut and the bean. When they have seen all these parts, the children can glue, tape or draw them on paper. (This part of the procedure should take 10 - 15 minutes.)

4. Ask the class, "Is the peanut or the bean in any way like the orange?" The children should recognize that the peanut is a fruit like the orange, with (1 or 2) seeds inside it, while the bean is a seed. They will probably know that beans come from a pod, and that the pod is the fruit.

5. Ask, "Can you describe a fruit now?" (It is the part of a plant which contains the seeds, protecting them and providing them with food.) From later activities the children will learn that the fruit often helps the seeds to travel, but this is not obvious from this activity.

6. Then ask, "What is a seed?" (It is a baby plant with its food supply.)

7. Make sure that the children have all seen the parts of the bean mentioned. Perhaps they can write these names beside the parts which they have already fastened or drawn on their papers.

EVALUATION

The class will probably want to know the uses of the parts of the fruit and seed. You could ask for suggestions of ways to find out what a fruit or seed can do. The children may suggest planting whole fruits or seeds or their parts; this will lead naturally to growing seeds, or to the activities on dispersal.

30 minutes
---
groups of 2

B

HOW DOES YOUR GARDEN GROW?

DESCRIPTION

By planting seeds under different conditions and watching them grow, the children try to solve the problem: "What do seeds need to grow into plants?"

OBJECTIVES

To introduce the children to the conditions necessary for healthy plant growth.

To practice various skills useful for laboratory experiments: observation, measurement and recording the process of growth.

MATERIALS

From the Box: radish and/or grass seeds; soil; paper cups; any unused peanuts and beans.
From the classroom: construction paper; pencils; scissors; clear tape; water; measuring spoons.

PROCEDURE

The experiment will take about 20-25 minutes to set up; you should try to allot 10 minutes per day during the next week for the class to observe and record the growth of their seeds.

1. Pass out to each pair of children: 2 paper cups half filled with soil; about 30 seeds. Ask the class to tell how they would plant the seeds. Let each pair plant ONE paper cup, being sure to:

   (a) write their names and the name of the seeds on the paper cup.
   (b) count the number of seeds planted and write it on the paper cup.
   (c) scatter the seeds evenly and press them into the soil with a pencil.
   (d) add about 1 tablespoon of water to the soil.
   (e) place the papercups in a warm, light place, such as a

windowsill.

(f) remember to add 1 tablespoon of water every day. This part of the procedure will probably take about 10 minutes.

2. Discuss with the class, "How could we find out what seeds need so that they can grow into healthy plants?" The children will probably suggest trying to grow some seeds without soil,,water, light and warmth. Let each pair of children plant a second paper cup as before, but this time leave out <u>either</u> soil <u>or</u> water; or else place the cup of soil, water and seeds in a dark cold place such as a refrigerator, or on a stone floor in a corner. The children may suggest leaving air out, too; let them try to think of a way to do this in the classroom.

3. Explain that each pair will watch and keep a record of their own seeds' growth. Ask them what they will want to record; they will probably decide to:

   (a) count the number of seeds which grow in each paper cup.
   (b) record the height of the seedlings daily. (They can cut strips of construction paper to show the height of one seedling and glue each strip to paper, with the date. An alternative method is to dig up one seedling each day and trace round it on paper, showing its height and the stages of its growth.)

4. At the end of the week, look over the results and discuss them with the children. They may notice that the only healthy seedlings are the ones growing in the paper cups with soil, water, warmth and light.

5. After discussing the records and results, try to bring out the fact that not all seeds grow into plants wherever they are planted; but that the number which grows increases if the seeds have the necessary water, soil, warmth and light.

FOLLOW-UP ACTIVITIES

1. The class could repeat these growing experiments without further instructions from you, using any unused peanuts or beans; the children might also try growing roasted peanuts.

2. In order to relate the results of the class experiments with what happens out-of-doors in spring and summer, the class could make a field trip to count seedlings immediately under, as well as within 5-yard and 10-yard radii of trees such as maples and oaks.

30 minutes
---
whole class

C

GETTING TO KNOW SOME FRUITS

DESCRIPTION

The children examine and draw a selection of fruits to observe the variations in appearance, texture and design.

OBJECTIVES

To have the children use their own abilities in finding out about the fruits. In the process, they should learn the names of the fruits and notice that fruits, like their parent plants, vary greatly in appearance.

MATERIALS

<u>From the Box</u>: the eight basic fruits; data charts for these eight fruits; magnifiers; toothpicks.
<u>From the classroom</u>: drawing materials.

PROCEDURE

1. Pass out the fruits, magnifiers and toothpicks so that each child has one of each fruit, a magnifier and a toothpick. Do this with as little introduction as possible, in order to work up suspense. Have the data charts placed around the room for easy reference.

2. Give each child time to explore each kind of fruit (the coconut should be passed round the room). This will take about 10 minutes. Ask the children to write down their findings or draw the fruits in detail. (The drawings should be large since they may be used later on a wall chart.)

3. Ask the class what they were able to find out about the fruits, and how they found out these things. List some of the answers on the board. Questions to which the children may have found answers are:

   (a) Is this a fruit or a seed? How do we know which it is?
   (b) What is its name?
   (c) Where does it grow? Where does it come from?
   (d) Is the outer cover special in any way: hard, waxy, fluffy, sticky? (Let the children suggest such descriptive words in the discussion.)

(e) Is there anything special about the size, weight, shape, color or odor?
(f) If it is a fruit, how many seeds are there inside?
(g) Do you think anything would eat this?
This part of the procedure will probably take up to 10 minutes.

Memorization of the names of all the fruits is not necessary, but familiarity with them is important.

EVALUATION

The children can play "I am thinking of something....," with the class asking one child questions requiring "yes" and "no" answers until they guess which fruit he is thinking about. (This could be played for about 10 minutes at the end of the lesson.)

Repeat this once or twice on subsequent days to review the characteristics and names of these fruits.

NOTE!

If part of a burdock gets in a child's eye, it can cause serious eye damage. Therefore, warn children not to rub their eyes after examining the burdock.

30 minutes
---
whole class

D

FRUITS ON THE MOVE

DESCRIPTION

The children experiment with the fruits to find answers to the question: "How could these things travel?" The class then sets up a wall chart on which they place the pictures of fruits which they drew in Lesson C, according to their possible modes of travel.

OBJECTIVES

To show that fruits enable seeds to travel in various ways from the parent plant to a new location. The children will be able to predict the methods of travel and test their predictions by experimenting.

MATERIALS

From the Box: Fruits of oak, cranberry, maple, burdock, milkweed, coconut, catalpa, grapple plant, magnifiers, paper cups.
From the classroom: water, large pan, drawing materials.

PROCEDURE

1. Pose the problem: "You are riding your bike down a street, and you see an empty lot filled with little plants. You also see these plants growing up through cracks in the sidewalk. How do the plants get there? Does someone plant them? Could a seed travel there on its own?"

2. After discussing this problem for 2 or 3 minutes, until the class realizes that seeds do get dispersed, pass out the fruits to the class, so that each child receives an acorn, a cranberry, a maple fruit, a burr, a milkweed pod or seeds, and a catalpa pod or seeds. Leave the coconut, grapple plant pods, magnifiers, paper cups, pan and water on a side table for use by those who wish to experiment with them.

3. Tell the children that they should investigate these fruits to find out how the fruits might travel. Do not tell the class what to do, but tell them that they may use any materials in the room for their investigations. After 10 minutes, have the children gather

their fruits and arrange them on their desks according to the ways in which the fruits could be made to move.

4. Then the class and teacher can begin to fill in the wall chart on a large sheet of paper, using pictures and information contributed by the class. Each fruit could be listed as having more than one method of travel. You might arrange the chart like this:

ACORN	MAPLE
Rolling	Spinning
Floating	Flying
CRANBERRY	
Rolling	
Floating	

FOLLOW-UP

Ask a leading question: "Why do certain fruits travel the way they do?" This could lead to activities E, F, G and H.

30 minutes
---
whole class

E

AIRBORNE: or, WINGS AND DISCS

DESCRIPTION

The children experiment with fruits and seeds to find out which can be carried by the wind.

OBJECTIVES

To show how certain seed structures are particularly adapted to wind dispersal.

MATERIALS

<u>From the Box</u>: milkweed seeds, maple fruits, catalpa seeds (you will have to open some pods to get the seeds), yucca seeds, acorns, cranberries.

<u>From the classroom:</u> scissors, paper for making pleated paper fans, drawing materials.

PROCEDURE

1. Ask each child to choose <u>one</u> of the fruits or seeds from the above list to use in his experiments. Give out one or two of his choice to each child. Let the children decide for themselves how to create the effect of wind in the classroom. (If necessary, show them how to make a pleated paper fan). This will take about 5 minutes.

2. When the children are ready to begin their experiments, ask them to keep a careful record of the distance the seeds travelled and the time they stayed in the air. (You can expect these results: Maple fruits will spin, dip and fall to the ground quite quickly; catalpa and yucca seeds will spin round and take longer to fall; milkweed seeds will float, affected by the slightest breath, and will stay up the longest; acorns and cranberries will fall straight down and will bounce or roll.) This part of the procedure will probably take about 10 minutes.

3. Let the children exchange seeds and try their experiments on several different seeds or fruits. This will probably take another 10 minutes.

4. Ask the children which part of the fruit or seed enables it to travel by wind. You can demonstrate, and the children can try cutting pieces of the wings off the fruits and seeds in order to see how much of the wing is needed to keep the fruit or seed in the air.

5. If they have not already done so, the children can draw pictures of the seeds or fruits with which they experimented, and add these drawings to the wall chart.

FOLLOW-UP

1. Ask the children to think of flying things which move the way the fruits and seeds do.

2. Weigh flying and non-flying fruits and seeds and see if the weight is related to the method of travel.

30 minutes
+ 10 minutes
---
groups of 2

F

FLOATING FRUITS

DESCRIPTION

The class experiments with fruits to find out how some can float in water for several days or longer, while others sink after a short time.

OBJECTIVES

To convey the idea that fruits which float for a long time have special structures to help them do so. This will involve the skills of devising and designing experiments, recording and classifying.

MATERIALS

From the Box: fruits of oak, burdock, maple, cranberry, milkweed, coconut, data charts for these fruits, navigator plant pods, paper cups, toothpicks, magnifiers, large world map, small world maps for the class.

From the classroom: water, colored pencils or crayons.

PROCEDURE

This activity will take one lesson to set up; you will need part of another lesson 2 or 3 days later to note and discuss the results.

1. Pass the coconut around the class and tell the class how it travels in ocean currents and has been distributed around the world. (See "Background Information.") Refer to the large world map and to the coconut data chart to show where the fruit grows. If the class wants to see it float, allow the whole coconut or half of it to float in a large pan of water for a day or two (but please dry it off before returning it to the box).

2. Tell the class about the navigator plant, and how its fruits (pods) travel from Brazil to Northern Europe via the Gulf Stream. (See "Background Information.") Let the children look at and handle the pods, and refer to the large world map.

3. The class can draw in color on their own small outline maps

of the world the journeys of the coconut and navigator plant pod and name the countries where they grow. <u>This should only be done</u> if the class has worked with world maps before and can understand the great distances involved. If the children ask, "How long did the journeys take?" tell them that no one knows exactly, but that the fruits must have floated for weeks or even months.

4. Give each pair an acorn, a cranberry, a burr, a maple fruit and a few milkweed seeds. Ask, "How could we find out if any of these fruits or seeds could travel long distances by water, as the coconut and navigator plant pod do?"

5. As far as possible, let the children carry out, in pairs, the experiments they think of. Most of these will involve floating the fruits and seeds in water in the paper cups. Each pair should be encouraged to watch the fruits carefully for at least 2 or 3 days, filling up the paper cups with water when necessary.

6. After 2 or 3 days, ask the class to report on its results. You will probably find that: all the maple fruits sink; some acorns and burrs, and milkweed seeds without parachutes, remain floating; all cranberries, except damaged ones, are still afloat.

7. Discuss the fact that cranberries seem to be the only one of these fruits which might be able to float for some time, and let each pair dissect its cranberry and try to find out what makes it float so well. The class may also use magnifiers. This will take about 5 minutes.

8. The children will find that each cranberry has a tough waxy waterproof skin, white spongy pulp, and 4 small air spaces, each containing a hard brown seed. The first 3 of these parts help the fruit to float. Refer to the cranberry data chart to see why the buoyancy of the cranberry helps it to disperse.

9. Ask, "Can we find anything in the coconut and navigator plant pod which might help them to float like the cranberry?" The class will see that both these long-distance travellers have a tough waterproof covering, that the coconut has air spaces in the fibrous husk and inside the "nut", and that the navigator pod is flat and boat-shaped.

EVALUATION

The class should realize that the main factors which determine buoyancy are: shape (a large surface in contact with the water); density ("lightness"); and the presence of air.

30 minutes
---
groups of 2

G

HITCH-HIKING FRUITS

DESCRIPTION

The children use information from experiments, data charts, and previous experiences to answer the question: "How do acorns, burrs and and bayberries travel?"

OBJECTIVES

To use observations and previous knowledge in order to deduce connections and interdependency between plants and animals.

MATERIALS

From the Box: fruits of oak, burdock and bayberry; data charts for these fruits; grapple plant pods; pieces of fur, magnifiers.
From the classroom: drawing materials.

PROCEDURE

1. Let the children review the names of the acorn, burr and bayberry by matching the fruits to the data charts and name cards.

2. Referring to the previous activities and experiences of the children, ask the class: "Can these fruits travel from place to place? Could they be blown about, or float long distances? If not, how could they move?"

3. Give each pair an acorn and a few bayberries. Ask, "What are these? Where do they grow? Are they edible? What eats them?"

   Some children will probably suggest that acorns are stored for winter food supplies by squirrels, chipmunks and some birds, like the bluejay. From the data chart for the bayberry, the class will see that the myrtle warbler, among other birds, eats many bayberries and probably carries away many more that it does not eat.

4. Hand out burrs and pieces of fur to each pair. The class will very soon find out, if it does not know already, that a burr is sticky. Tell the children to find out what kinds of things the burr will stick to. Ask: "Could any of these things be found where the burdock plant grows?" Refer to the data chart for the burdock.

The children should suggest that birds and people and many kinds of animals with fur might pass by a burdock plant and pick up some burrs.

5. Then ask: "What makes the burr so sticky, that it can 'hitch-hike' on these animals?" Give out magnifiers and make sure that everyone sees the tiny hooked barbs (bracts) on the burr. The class could than draw the burrs as seen under the magnifiers.

6. Let the children look at the grapple plant pods. (Take care in handling them as the hooks are very sharp.) Discuss with the class what kind of animal might carry these fruits, and how the fruit would become attached to the animals.

FOLLOW-UP

The children can write short compositions about fruits carried by animals and birds. They can also collect pictures of animals gathering and storing food for the winter.

30 minutes
---
whole class

H

THE STORY OF AN ISLAND

DESCRIPTION

The teacher (or the class in pairs) reads a story of the colonization of a volcanic island to find out how plants and animals get to a new island.

OBJECTIVES

To give the children an idea of the variety of methods of seed dispersal.
To get the children to use knowledge from previous lessons to expand a simple account of seed dispersal.

MATERIALS

From the Box: 20 copies of the book, The Birth of an Island.
From the classroom: drawing materials.

PROCEDURE

1. The book The Birth of an Island can provide the basis for a good discussion by making information available to all the children. Read, or let the children read from the book, starting with pp. 5 - 15 and 26 - 29.

2. Discuss an island with the class: Have any of the children ever seen an island, or been on one? What was the name of the island? Was there anything on the island? People, houses, plants or animals? Which probably arrived first? How did they all get to the island?

3. Discuss the ways in which plants first arrived on the volcanic island described in the book. Try to make as long a list as possible (on the blackboard, or else have the children write it down) of the ways in which plants can be made to move. (You could compare this list with the ways people travel.)

4. After the discussion, let the children use their imaginations to make individual pictures (or let them make a large mural) of an island, gradually adding plants to the picture as they learn about them.

continuous
---
class in groups

I

FRUITS WE HAVE FOUND

DESCRIPTION

The children collect real fruits and seeds. They also collect pictures of fruits and seeds and make a display, grouping the fruits and seeds according to their means of travel.

OBJECTIVES

To extend the children's ability to recognize fruits and their means of dispersal. The children should realize that the things they have learned apply to a large range of fruits.

MATERIALS

From the Box: any of the fruits; tooth picks; magnifiers.
From the classroom: construction paper; glue; fruits already collected; pictures of fruits and seeds.

PROCEDURE

1. This lesson should take the form of a class project. The children can be divided into groups, or else they can all contribute informally to the project each day, once the framework has been established.

2. There are several steps in such a project:

   (a) examine the fruits and seeds to determine how they travel; (there might be more than one good way in which a seed could be dispersed.)
   (b) decide on headings for the display area, such as "Animal-dispersed", "Man-dispersed", "Wind-dispersed", "Water-dispersed", or other appropriate headings.
   (c) arrange the collected fruits and pictures according to the heading under which they fall.

EVALUATION

If the children can do most of this project unaided, you will have a good indication of how much they have learned from previous activities.

30 minutes
---
whole class

J

WHO PLANTED APPLE TREES?

DESCRIPTION

The children discuss plants useful to man, and think of some reasons for human dispersal of seeds. They then listen to the story of Johnny Appleseed.

OBJECTIVES

To have the children think about how and why man disperses seeds, by learning about a special case.

MATERIALS

From the Box: large world map and small maps of the U.S.; book, The Story of Johnny Appleseed; fruits (burdock, maple, coconut, bayberry, grapple plant, grass seed, peanuts).
From the classroom: any fruits and seeds collected by the class (including, if possible, apple seeds, grapes, oranges).

PROCEDURE

(This is less active than other suggested lessons. It can be used to show the relationship between seed travels and human geography.)

1. Show the children a variety of fruits and seeds. Then ask them: "Are these seeds useful to man? Which parts do men use: the seeds, the fruit, or the whole plant? How do they use it?"

2. After talking about some of the fruits and seeds (apple seeds should be among them), read, or have the children take turns reading, the story of Johnny Appleseed. As the story progresses, point out the route that Johnny may have taken, as shown by the areas where most apple trees now grow.

3. When the story is finished, the children can do a variety of activities:
   (a) map the route of Johnny Appleseed on the small outline maps of the U.S.
   (b) draw their own pictures to illustrate the story.
   (c) think of reasons why Johnny Appleseed distributed apple trees.
   (d) plant apple seeds and find out about apple products.

20 - 30 minutes
---
individuals

K

PLANT TRAVELS

DESCRIPTION

The children use the results of their investigations to write a story about one seed's travels.

OBJECTIVES

To consolidate the children's knowledge of fruits, seeds and their dispersal.
To give the children an opportunity to use imagination and creative ability; to describe space and time; to communicate and explain facts.

MATERIALS

From the Box: any fruits and seeds; data charts.
From the classroom: tables and desks for displaying fruits; writing and drawing materials.

PROCEDURE

1. Display all the remaining fruits and seeds from the box (and any others which were collected) on tables round the room, along with the data charts for the eight basic fruits.

2. Allow the children 5 to 10 minutes to move around and review the the fruits, their names and their methods of travel, so that everyone is familiar with as many fruits as possible.

3. Explain that each child is to choose a fruit or seed and to imagine the travels it might make. He will then write a short story about this plant, including where it grows, the way in which its seeds travel, where the seed lands, and its growth into a new plant. (Possible titles, used by children in tryouts, are: "I am a .....", "The Story of a Volcano", "The Birth of an Island".)

4. As an alternative, the children could draw pictures to illustrate a seed's travels.

IV - BACKGROUND INFORMATION FOR THE TEACHER

FRUITS AND SEEDS

The fruit is the plant structure which contains the seeds. The seed is the unit which will grow into a new plant. In some cases it is hard to differentiate between the two, but the specimens in the box are all clear-cut cases. Both the seed and the fruit may have special adaptations for dispersal, and these are discussed below.

In the following list of fruits, asterisks * indicate the eight basic fruits for which you will find data charts.

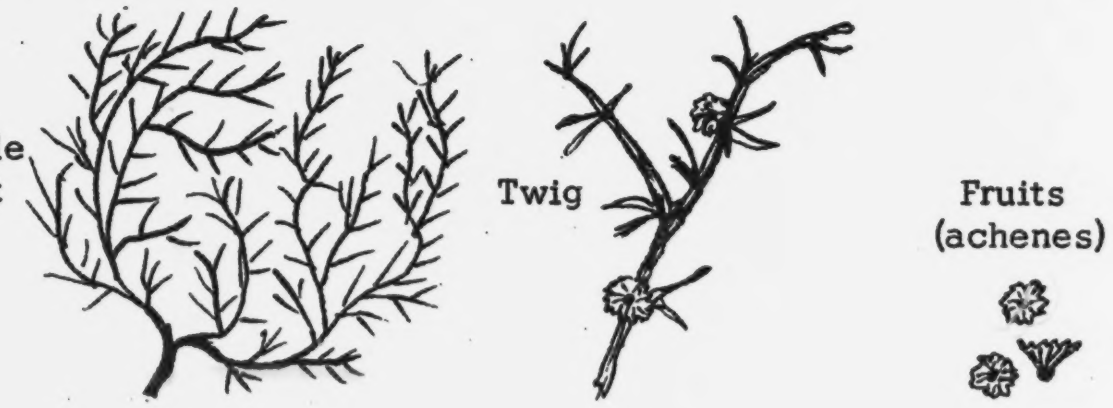
1. The achene (a-ken): a small, one-seeded fruit, which does not open to release the seed. It is similar to a nut, but smaller and not so hard. In the box there are two kinds of achenes - those of burdock and tumbleweed.

* Burdock: the fruit or "burr" is really made up of many achenes, each containing one seed, and each having been formed from a single tiny flower. The bracts surrounding all the flowers in the flower-head are hooked at the tips and remain on the compound fruit. This enables the burr to cling to fur, feathers or clothing, and so it may be dispersed by a passing animal, bird or person.

Section through a burr

Tumbleweed: this plant grows on flat, windswept prairies. The whole plant, with many small achenes on it, snaps off just above the ground and is tumbled along by the wind, scattering the fruits as it goes.

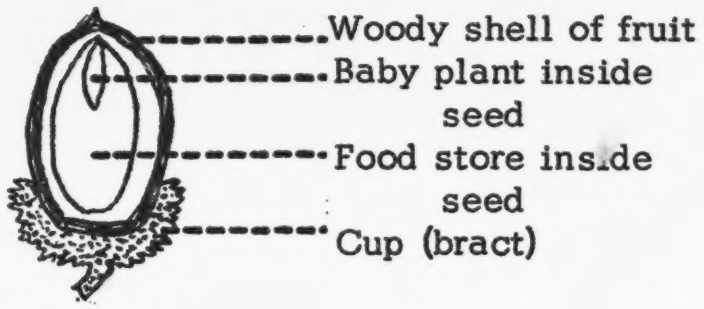
Tumbleweed



2. The nut: this is a dry fruit, containing one or two seeds, which does not split open to release the seeds. It has a hard woody covering. In the box you will find nuts of the oak (acorn), coconut and bayberry. (The bayberry will for practical purposes be considered as a berry.)

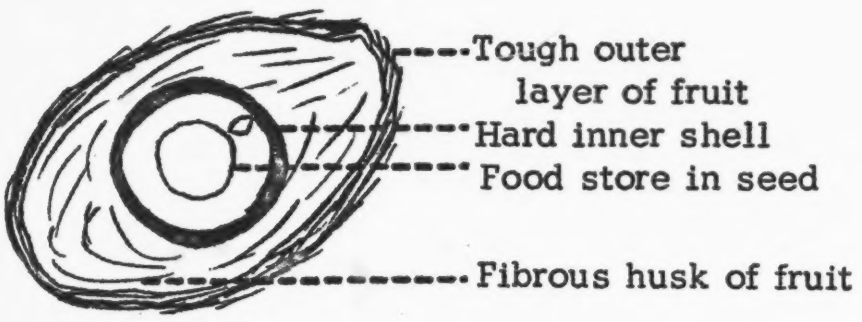
* Oak (acorn): this nut has a woody cup which is not really part of the fruit, but is made from a bract. Acorns are dispersed by squirrels, chipmunks and other mammals and birds which use them as a winter food supply.

Section through an acorn



* Coconut: this large nut is adapted for water dispersal by having a tough water-proof outer covering, a fibrous husk for buoyancy, and a hard inner shell protecting the seed.

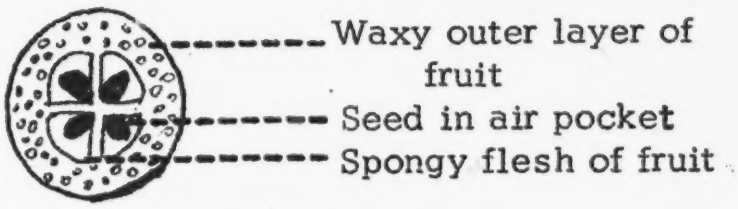
Section through a coconut



3. The berry: this is a fleshy fruit in which the only hard part is the seeds. In the box there are cranberries and bayberries.

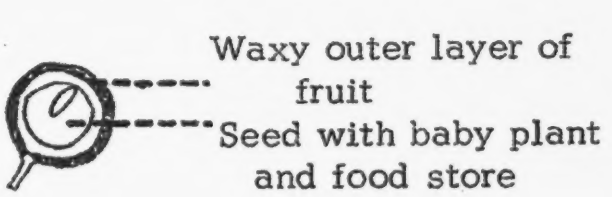
* Cranberry: this berry usually contains four seeds, each one in an air pocket. They are surrounded by spongy flesh and a waxy, water-proof outer covering, both of which help the fruit to float well in water while the seeds are dispersed.

Section through a cranberry



* Bayberry: although this is strictly a nut since it contains one seed, we can refer to it as a berry with a waxy outer layer. This helps the fruit to stick to the beak of the bird that eats it. When a bird rubs the berry off on a branch, the seed falls and is dispersed in this way.

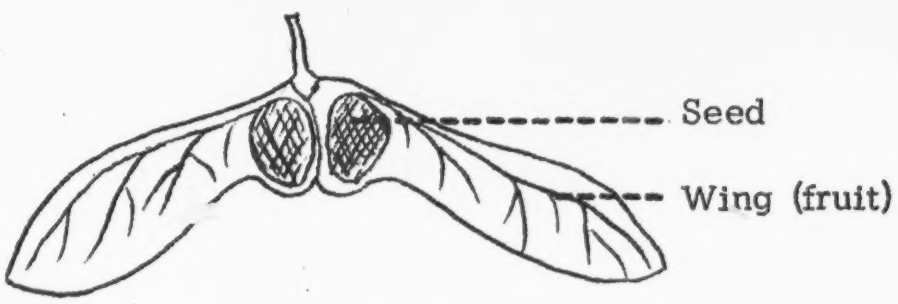
Section through a bayberry



4. The samara (sa-ma-ra): this fruit is a specialized achene, with a flat wing for wind dispersal. In the box, the maple fruits are samaras.

* Maple: this fruit is really a double samara, each half containing a single rather hard seed at the narrow end. The flat wings enable the fruit to be carried on air currents or blown by the wind.

Maple fruit

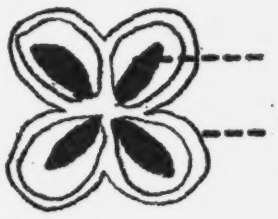


5. The capsule: a dry fruit which opens down one side to release a large number of seeds. In the box you will find capsules of witch hazel, yucca and grapple plant.

* Witch hazel: the capsule contains several hard brown seeds. It is an example of mechanical dispersal. In the fall (for this particular species of witch hazel) the capsules dry out, some tissue layers becoming drier than others. This sets up tensions in the walls of the fruit, which eventually splits open with considerable force, throwing the seeds out for a distance of several feet.

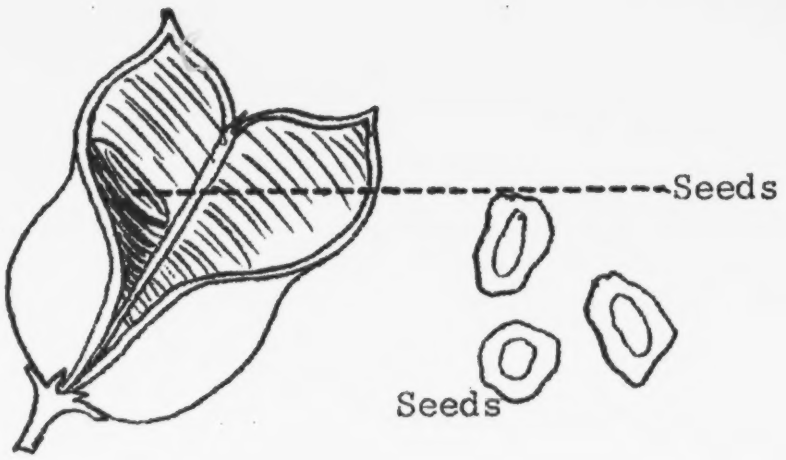
Witch hazel fruit

Section through capsule



Yucca: this capsule contains many flat seeds. The fruit splits open and the seeds are carried away by the wind. The plant usually grows in desert areas.

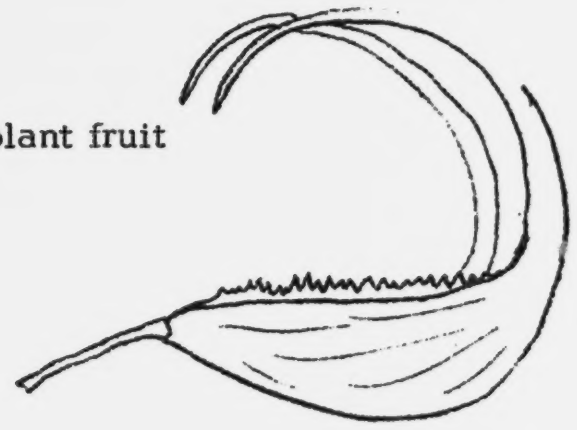
Yucca fruit



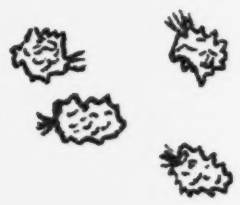
Grapple plant: in this capsule there are several hard seeds. The long curved and very sharp horns of the capsule adapt it for dispersal by deer, sheep, antelope and other hoofed animals which live

in the hot dry areas where the plant grows. The capsule catches around the feet of the animal and is carried along in this way.

Grapple plant fruit



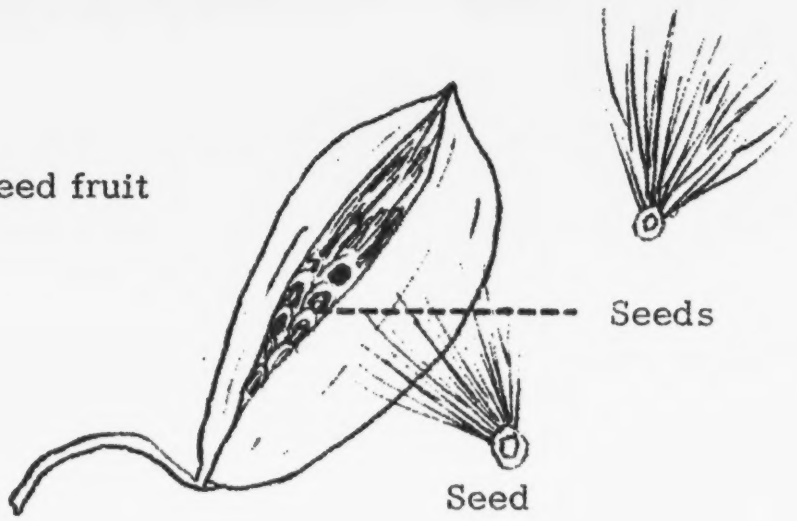
Seeds



6. The pod: this is an elongated fruit, usually containing more than one seed. It splits open down two edges to release the seeds. In the box there are pods of milkweed, catalpa, navigator plant and peanut.

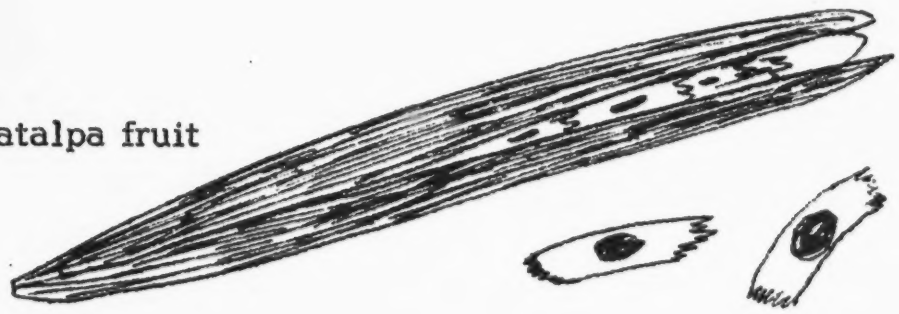
* Milkweed: a pod containing many seeds which are adapted for wind dispersal by having a pappus or tuft of hairs. This makes each seed light enough to catch the smallest breath of wind. The seeds can be carried for long distances in this way, and so milkweed is a very widespread plant.

Milkweed fruit



Catalpa: this pod contains many flat winged seeds. The fruit splits open and the seeds are scattered by the wind in the same way as the milkweed.

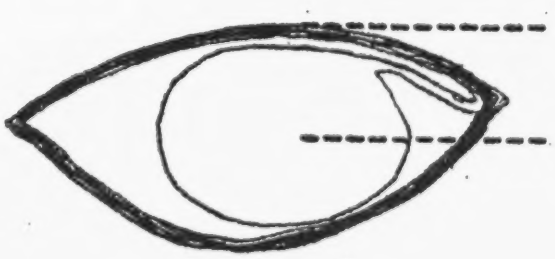
Catalpa fruit



Seeds

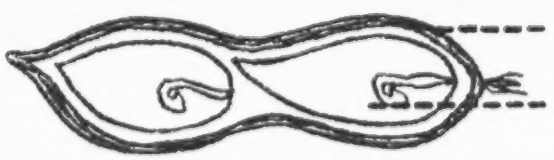
Navigator plant: this pod contains a single seed. The fruit is hard, water-proof and boat-shaped; it can be carried very long distances by water.

Section through navigator plant pod



Peanut: this pod grows underground and usually contains two seeds. It is planted for its oily seeds, and is therefore dispersed by man for economic reasons.

Section through a peanut



SEED DISPERSAL

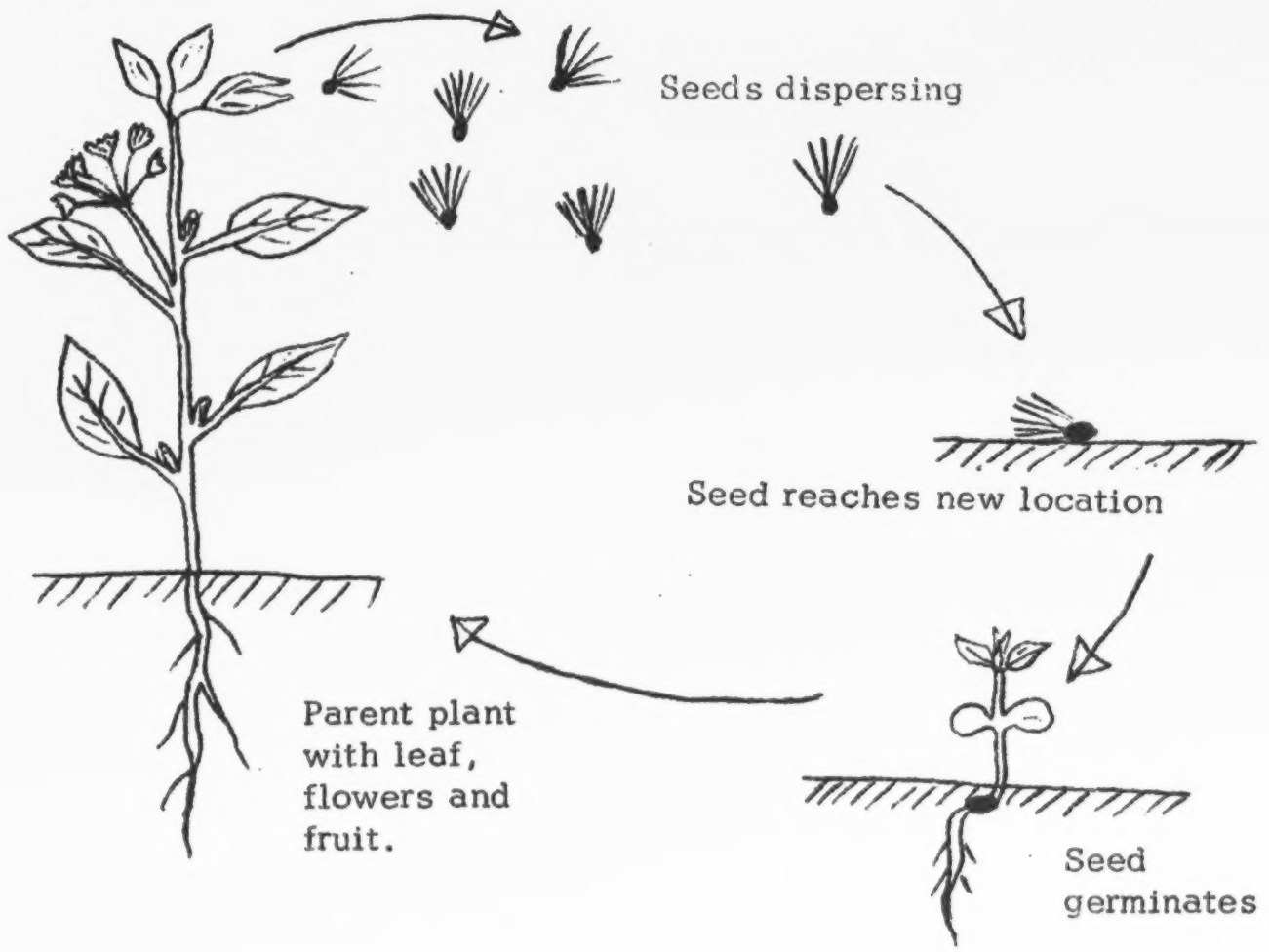
Seed dispersal is essentially a form of migration: the movement of plants away from an already established center (the parent plant). It is a biological necessity to prevent overcrowding and subsequent dying out of the young plants. If the seeds did not disperse, the competition for the various necessities of life would be too great.

These basic necessities are:

1. Soil and essential mineral nutrients
2. Water
3. Light
4. Air

On a larger scale, dispersal is also a means of ensuring the survival of the species. By guaranteeing a wide range of locations where the species is growing, it ensures that a localized disaster, while destroying individuals, will not affect the species as a whole.

Seed dispersal is one aspect of the life cycle of a plant. The children will see other aspects of this cycle when they grow the seeds in the box. A generalized life cycle can be shown by the following diagram:



SOME COMMON FRUITS AND THEIR METHODS OF DISPERSAL

FRUIT OR SEED	METHOD OF DISPERSAL
Ailanthus	wind
American Lotus	water
Apple	human
Ash	wind
Beggar's Tick	mammal
Blackberry	bird
Bladdernut	water
Broom	explosive
Cattail	wind
Chestnut	mammal
Chokeberry	bird
Citrus fruits	human
Coffee	human
Corn	human
Cotton	human
Crab Apple	bird
Dock	wind
Elm	wind
Fireweed	wind
Flax	human
Hackberry	bird
Hawthorn	bird
Hickory	mammal
Jewelweed	explosive
Linden	wind
Mistletoe	bird
Pansy, Violet	explosive
Phragmites	wind
Pine	wind
Rosehip	bird
Rowan	bird
Sticktight	mammal
Sumac	bird
Tick Trefoil	mammal
Wild Cherry	bird
Zanomia	wind

ORIGINS AND DISTRIBUTION OF SOME COMMON PLANTS

In most cases it is not possible to say with complete certainty where a plant originated, as most plants became widely distributed long before they were studied by man. However, Alfonso de Candolle, a Swiss botanist in the late 19th century, did a considerable amount of research on some of the plants whose seeds have been dispersed by man, and his conclusions are probably as accurate as it is possible to be.

These plants have been introduced to new places by man for agricultural purposes:

Plant	Place of origin	Present distribution
Corn	Central and South America	In temperate and subtropical countries all over the world.
Coffee	Abyssinia	In the tropics all over the world.
Oranges	China	In the tropics and subtropics all over the world.
Radish	Temperate Asia	In gardens in all temperate countries.
Cabbage	Europe	In temperate countries all over the world.
Lemons	India	In all tropical and subtropical countries.
Peach	China	In all temperate and subtropical countries.
Watermelon	Tropical Africa	In temperate, subtropical and tropical countries all over the world.
Cucumber	India	In all temperate and subtropical countries.
Banana	Southern Asia	In all tropical and subtropical countries.
Potato	Probably Chile and Peru	All over the world.

Plant	Place of origin	Present distribution
Tomato	Peru	All over the world.
Pumpkin	Temperate North America	Widespread in North America, also in some other temperate countries.

These plants were all dispersed deliberately by man for economic reasons. Man has also inadvertently distributed weeds over much of the world, often mixed in with the seed he took to a new location for planting. Most common roadside plants in the United States were introduced accidentally from Europe and Asia by the early settlers. A classic example is the tumbleweed, which was brought from Russia with flax seed. This seed was originally sown in South Dakota and the tumbleweed has now spread from this state to the West Coast.

OCEAN CURRENTS

The value of ocean currents for seed dispersal over long distances is actually quite slight. Although coconuts have been carried hundreds of miles by ocean currents, this is not an especially common occurence. More common and valuable is the way in which coconuts do travel from island to island in the tropics by means of the more local currents and tides. This is a common way for coconuts to be dispersed to otherwise deserted islands.

There are two striking classic examples of fruits travelling great distances by ocean currents. The Navigator Plant (Coesalpinia bonducella) and the Nicker Bean (Entada scandens) are native to the Amazon basin (Venezuela and Brazil), but they have travelled to Europe by means of the Gulf Stream. Entada scandens has been collected from European shores and has been successfully germinated at Kew, England's famous Royal Botanic Gardens. It is important to realize that these examples are exceptional, and that the real value of ocean currents for dispersal lies in a much more limited range.

GLOSSARY OF BOTANICAL TERMS

Axil : the upper angle between a leaf and the stem on which it is borne.

Bract : the leaf from whose axil a flower arises.

Coir : the stout fibres which run lengthwise in the outer husk of a coconut.

Copra : the dried kernels of young coconuts, from which coconut oil is extracted.

Deciduous: having leaves falling in autumn, or at the beginning of the dry season in tropical countries.

Floret: a small flower in a cluster of flowers, as in burdock.

Fruit: the plant structure formed from the pistil (female part) of the flower after fertilization by pollen from the stamen (male part).

Germinate : to grow from a seed into a seedling.

Habitat: the natural location where a plant grows.

Inflorescence: a cluster of flowers or florets, as in milkweed and burdock.

Latex: the milky fluid found in the stems and leaves of some plants, such as the rubber tree and milkweed.

Seed: the plant structure formed from the female cell inside the pistil after fertilization. (See Fruit above.) A seed is made up of a young plant with stem, root and leaves and its food supply, within a seed coat.

V - FURTHER EXPLORATIONS

THE CHILDREN'S MUSEUM , BOSTON,,provides the following things which could supplement the materials in the Box:

Loan Boxes
- Trees of New England
- Plants in Design
- Cotton
- Rice
- Wheat
- Sugar

Museum Programs (School Talks)
- Signs of Spring
- Living Things

From the LEARNING CENTER, INC., PRINCETON, NEW JERSEY, you can obtain:

Science Learning Laboratories
- #K600 "Miniature Seed Garden"
- #K601 "Experimental Greenhouse"

EDUCATIONAL SERVICES INC. (ESI), WATERTOWN, MASSACHUSETTS, supplies:

Elementary Science Kit
- "Growing Seeds"

CHILDREN'S BOOKS

Aliki — *The Story of Johnny Appleseed. New Jersey, Prentice Hall, 1963.

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" " — Play With Seeds. New York, Morrow, 1957.

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* Starred books are included in the Box.

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Snedigar, Robert — Our Small Native Animals. New York, Dover, 1963.

Stefferud, Alfred — The Wonders of Seeds. New York, Harcourt & Brace, 1956.

Zim, H.S. — Trees. New York, Golden Press, 1956.

* Starred books are included in the Box.

FILMS ON SEEDS AND SEED DISPERSAL

TITLE	PUBLISHER
Seeds Grow Into Plants	Coronet
Birds That Eat Seeds	International Film Bureau
Vacant Lot	International Film Bureau
How Seeds Are Scattered	McGraw Hill Films
Woodpecker Gets Ready for Winter	Moody Institute of Science
Seed Dispersal	Encyclopedia Britannica
Flying Seeds	Sterling Films
A Tree is Born	U.S. Dept. of Agriculture
Seed Dispersal	United World Films